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# IoT and Connectivity in automobile: A Review

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**Abstract**: This paper provides a comprehensive overview of the current state and future prospects of Internet of Things (IoT) and connectivity in the automobile industry. The paper delves into the evolution of connected vehicles, the role of IoT, and the transition towards autonomous vehicles. It discusses the challenges and issues faced in implementing IoT in connected vehicles, such as road safety, maximizing fuel efficiency, and reduction in traffic congestion and accidents. The paper also highlights the opportunities that IoT presents for automotive manufacturers, including operational aspects like telematics, predictive maintenance, software updates, infotainment services, value-added services, and the development of self-driving vehicles. Case studies of successful implementations of IoT in the automotive industry are included to illustrate the practical applications of these technologies. The paper concludes with a discussion on future trends in the field of IoT in automobiles, including the shift towards centralized service-oriented architectures and the role of physical connectivity in enabling these new architectures. This review serves as a valuable resource for researchers, practitioners, and policymakers interested in the intersection of IoT and automotive technology.

**Keywords***:* Internet of Things (IoT), Automobile Industry, Connected Vehicles, Autonomous Vehicles, Self-driving Vehicles

## I. INTRODUCTION

The advent of the Internet of Things (IoT) has revolutionized various industries, with the automobile industry being one of the most significantly impacted. The integration of IoT in automobiles has led to the emergence of connected vehicles, which are equipped with internet access and can share data with devices both inside and outside the vehicle. This paper titled 'IoT and Connectivity in Automobiles: A Review' aims to provide a comprehensive overview of the role of IoT and connectivity in the automobile industry.

The paper begins by tracing the evolution of connected vehicles, discussing how advancements in technology have gradually transformed traditional vehicles into smart, connected ones. It then delves into the role of IoT in this transformation, discussing how IoT technologies have been leveraged to enhance vehicle performance, safety, and the overall driving experience.

However, the implementation of IoT in automobiles is not without its challenges. Issues related to road safety, fuel efficiency, traffic congestion, and accidents are some of the key concerns that need to be addressed. The paper discusses these challenges in detail, providing insights into the complexities involved in integrating IoT technologies into automobiles. Despite these challenges, IoT presents numerous opportunities for automotive manufacturers. From telematics and predictive maintenance to software updates and the development of self-driving vehicles, IoT is set to redefine the future of the automobile industry. The paper highlights these opportunities, providing a glimpse into the future of connected vehicles.

The paper also includes case studies of successful implementations of IoT in the automotive industry, providing practical examples of how these technologies are being used in real-world scenarios. Finally, the paper concludes with a discussion on future trends in the field of IoT in automobiles, including the shift towards centralized service-oriented Architectures and the role of physical connectivity in enabling these new architectures.This paper serves as a valuable resource for anyone interested in understanding the intersection of IoT and automotive technology, providing a comprehensive overview of the current state of the field and its future prospects.

## II. BACKGROUND

The concept of Internet of Things (IoT) and connectivity in automobiles has its roots in the broader field of telematics. Telematics, a term that combines "telecommunications" and "informatics", refers to the technology used to monitor a wide range of information in motor vehicles. This includes data about the vehicle's movement, location, and internal systems.

The first generation of connected cars came with basic telematics solutions, providing features like GPS navigation, integrated hands-free cell phones, and automatic emergency notification. However, these systems were largely independent and did not interact with each other.

The advent of IoT has taken telematics to a whole new level, leading to the development of connected car platforms that integrate various vehicle systems to provide a seamless driving experience. These platforms leverage IoT technologies to collect data from a

variety of sensors installed in the vehicle, process this data, and use it to provide real-time feedback to the driver, automate various vehicle functions, and offer a range of in-car services.

The integration of IoT in automobiles has also paved the way for Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) communication, collectively known as V2X communication. V2X communication allows vehicles to communicate with each other and with infrastructure like traffic signals, providing drivers with real-time information about road conditions, traffic congestion, and potential hazards. This has significant implications for road safety, traffic management, and the development of autonomous vehicles.

The transition towards autonomous vehicles represents the next phase in the evolution of IoT in automobiles. Autonomous vehicles rely heavily on IoT technologies to sense their environment, make decisions, and navigate without human intervention. As such, they represent the ultimate expression of IoT and connectivity in automobiles.

In conclusion, the integration of IoT and connectivity in automobiles represents a major technological shift that has transformed the way we drive. From basic telematics solutions to connected car platforms and autonomous vehicles, the evolution of IoT in automobiles is a fascinating journey that continues to shape the future of the automotive industry.

**Challenges and issues:**

a. **Data Security and Privacy**: With vehicles collecting and transmitting vast amounts of data, ensuring the security and privacy of this data is a major challenge. This includes protecting the data from unauthorized access and ensuring that it is used in a manner that respects user privacy.

b. **Interoperability**: With numerous devices and Systems involved in a connected vehicle, ensuring that these components can communicate and work together seamlessly is a significant challenge.

c. **Reliability**: Given that many of the systems in a connected vehicle are critical for its operation and safety, ensuring the reliability of these systems is paramount.

d. **Regulation**: The rapid pace of technological advancement in the field of IoT and connected vehicles has outpaced the development of regulations governing their use. This creates a regulatory gap that poses challenges for both manufacturers and users.

e. **Infrastructure**: The full potential of connected vehicles can only be realized with the necessary infrastructure in place. This includes everything from communication networks to traffic management systems.

f. **Cost**: The cost of implementing IoT technologies in vehicles can be high, making it a challenge for manufacturers to deliver affordable vehicles that include these features.

These challenges need to be addressed in order to fully realize the potential of IoT and connectivity in automobiles. However, with ongoing advancements in technology and growing awareness of these issues, solutions are being developed to overcome these challenges.

**Opportunities:**

a. **Telematics**: IoT enables advanced telematics services such as real-time vehicle tracking, remote diagnostics, and predictive maintenance. These services can enhance vehicle performance, improve safety, and provide a better driving experience.

b. **Infotainment Services**: Connected vehicles can offer a range of infotainment services, from streaming music and video to providing real-time news and weather updates. This can enhance the in-car experience and provide additional value to customers.

c. **Safety and Security**: IoT technologies can enhance vehicle safety and security. For example, connected vehicles can automatically contact emergency services in the event of an accident. They can also provide real-time alerts about potential security threats.

d. **Autonomous Vehicles**: IoT is a key enabler of autonomous vehicles. Connected vehicles can communicate with each other and with traffic management systems to navigate safely and efficiently without human intervention.

  

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e. **Efficiency and Sustainability**: IoT can help improve fuel efficiency and reduce emissions by optimizing vehicle performance and driving behavior. This can contribute to sustainability efforts and help manufacturers meet regulatory requirements.

f. **New Business Models**: The data generated by connected vehicles can be used to develop new business models. For example, insurance companies can offer usage-based insurance policies that take into account a driver's behavior and vehicle usage.

These opportunities represent a significant potential for growth and innovation in the automotive industry. However, realizing these opportunities will require addressing the challenges associated with implementing IoT in automobiles.

**Case study:**

What is connectivity and IoT in automobile?

Connectivity and Internet of Things (IoT) in automobiles refer to the integration of internet connectivity and IoT sensors into vehicles, creating sophisticated systems that enhance vehicle performance and user experience.

A connected car is a vehicle that uses internet connectivity to communicate with outside systems. These systems can include apps that can unlock your car, GPS, and vehicle-to-vehicle communication. Internet- and cloud-connected cars collect and transmit large amounts of data, which is then used to design safer roadways, predict equipment malfunction, and improve the in-car entertainment experience.

IoT in the automotive industry, particularly with the integration of IoT sensors and connected devices, enables a transformative upgrade in the car manufacturing process Modern cars, now dubbed "connected cars," function as sophisticated systems equipped with IoT solutions that blend sensors, cloud computing, mobile applications, and more. This seamless integration of automotive IoT solutions enhances fleet management, predictive maintenance, insurance, and connectivity between cars and Original Equipment Manufacturers (OEMs).

The intersection of IoT and automotive technology has given birth to smart cars and connected vehicles, disrupting our concept of mobility. In this intelligent ecosystem, cars aren't merely machines that get us from point A to B but comprehensive platforms capable of delivering unprecedented efficiency, safety, and personalized experience

## III. TYPES

1. **Vehicle-to-Vehicle (V2V):** This technology allows vehicles to communicate with each other, sharing information about their speed, direction of travel, and other operational data to improve road safety.

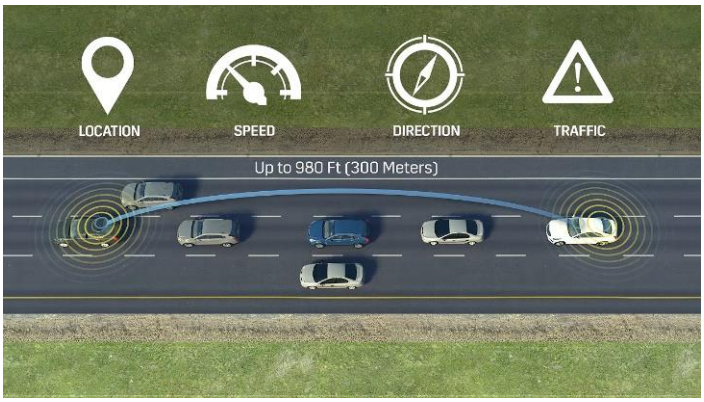


Fig. no. 1: V2V

2. **Vehicle-to-Infrastructure (V2I):** This technology allows vehicles to communicate with road infrastructure, such as traffic lights and toll booths, providing drivers with real-time information about road conditions, traffic congestion, and potential hazards.

  

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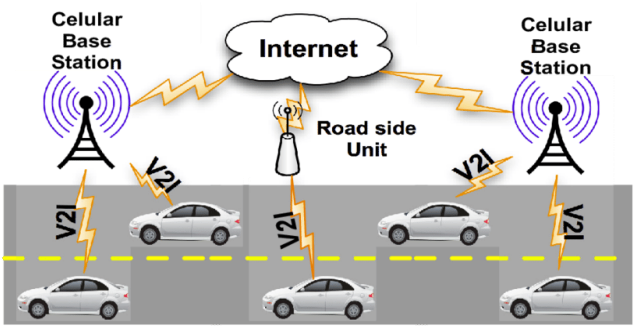


Fig. no. 2: V2I

3. **Vehicle-to-Pedestrian (V2P):** This technology allows vehicles to communicate with pedestrians, alerting them to potential hazards and improving pedestrian safety.

Fig. no. 3: V2P

4. Vehicle-to-Device (V2D): This technology allows vehicles to communicate with devices such as smartphones and traffic sensors, providing a range of services from infotainment to traffic management.


Fig. no. 4: V2D

5. **Vehicle-to-Network (V2N):** This technology enables vehicle-to-vehicle communication over wireless networks, such as LTE.

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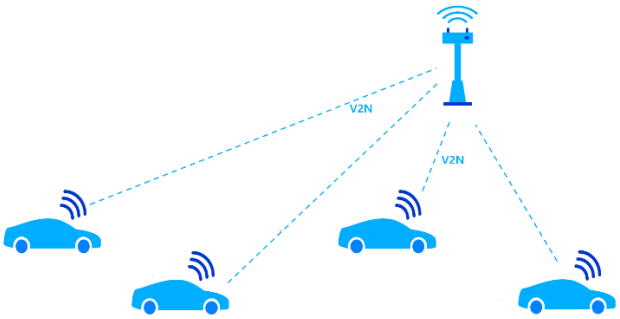


Fig. no. 5: V2N

6. **Vehicle-to-Grid (V2G):** This technology is still being developed but centers around the idea of using batteries in electric cars and trucks as a power source in the electrical grid based on real-time demands for power

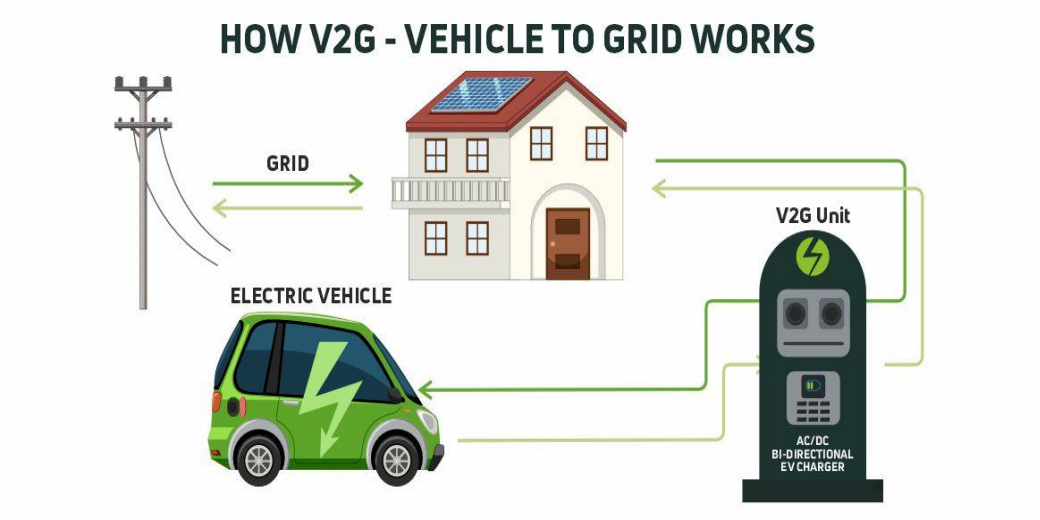


Fig. no. 6: V2G

7. **Vehicle-to-Everything (V2X):** This is a comprehensive term that includes all types of communication involved in the operation of a vehicle, including communication with pedestrians, devices, and the internet.

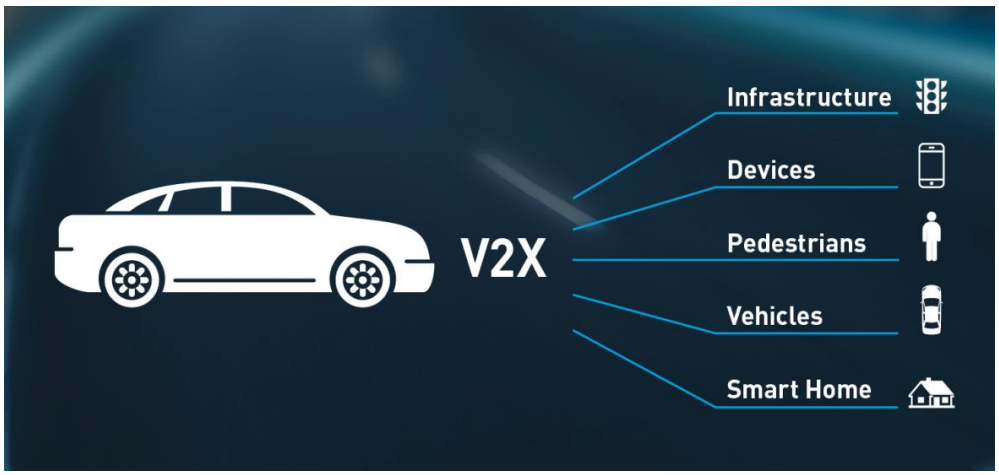


Fig. no. 7: V2X

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These technologies are transforming the automotive industry, turning vehicles into smart means of transportation that offer enhanced road safety and driving efficiency.

## IV. CURRENT TRENDS

1. **India:** The connected car market in India is anticipated to register a CAGR of about 20% during the forecast period (2020 - 2025). Artificial intelligence and Internet of Things (IoT) were initially part of luxury and high-end cars in mature markets such as Germany and the United States. However, in recent years, India has seen interest from various OEMs to incorporate advanced technology in Indian cars. For instance, MG India partnered with Airtel for connected mobility solutions with an E-SIM, and the company claims that it is Internet Protocol Version 6 (IPV6) ready for the upcoming 5G.


Fig. no. 8: MG Hector (Internet Inside)

2. **Global Trends**: As vehicles become connected at scale, automotive manufacturers have an opportunity to leverage a number of new innovations such as 5G and IoT. With continuous developments in connected vehicle ecosystems, the proliferation of electric vehicles, and the technological shift towards autonomous vehicles, the automotive sector is on the precipice of innovation and widespread change. Manufacturers are building new products and launching new services with the aim to enhance the driving experience of their customers. Internet of Things (IoT) will be at the center of all this to enable this technology shift.

## V. FUTURE TRENDS

**1. 5G Connectivity:** The much-anticipated arrival of 5G technology will be essential in facilitating new services such as private networks, streaming of high-definition maps, and collaborations with Over-the-Top (OTT) players for content streaming. 5G connectivity could redefine the automobile industry as we know it**.**

2. **Connected Vehicle Platforms**: Connected vehicle platforms will emerge as a key element to the development of vehicle autonomy as a critical enabler to the optimal connectivity coverage, having a unified visibility to the connected vehicle fleet and providing the right insights to execute a Software over the Air (SOTA) campaign.

3. **Vehicle-to-Everything (V2X) Connectivity:** Connectivity will remain central to the development of vehicle autonomy, and without it, manufacturers will not be able to achieve V2X – or 'vehicle-to-everything' connectivity – the two-way communication between the vehicle and other devices around it that makes autonomous vehicles truly viable.

4. **Market Growth:** The market for connected cars is predicted to soar to over $215 billion by 2027. Connected cars are potentially safer for road users, and less harmful to the environment. They open up new revenue streams for the car industry, with features such as remote diagnostics, predictive maintenance, and online service scheduling.

5. **Consumer Experience:** Driver demand for connectivity is increasing as people become more familiar with the benefits of staying connected. According to McKinsey, 40% of consumers would change car brands just to gain more connectivity within their vehicles, rising to 61% for drivers in China.

These trends indicate a significant shift towards connected and smart vehicles, driven by advancements in IoT and connectivity technologies.

## VI. CONCLUSIONS

The integration of IoT and connectivity in automobiles is a transformative force in the automotive industry. This technical paper titled “IoT and Connectivity in Automobile: A Review” has provided a comprehensive overview of the current state and future prospects of this technology. From the evolution of connected vehicles to the role of IoT in this transformation, the paper has explored various facets of this topic. It has highlighted the challenges and issues faced in implementing IoT in connected vehicles, as well as the opportunities that IoT presents for automotive manufacturers. The paper has also included providing practical examples of how these technologies are being used in real-world scenarios. Finally, the paper has discussed future trends in the field of IoT in automobiles. As we move forward, it will be interesting to see how these technologies evolve and shape the future of mobility. This review serves as a valuable resource for researchers, practitioners, and policymakers interested in the intersection of IoT and automotive technology.

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